Running head: APPRAISAL-DRIVEN RESPONSE PATTERNING

Appraisal-Driven Somatovisceral Response Patterning:

Effects of Intrinsic Pleasantness and Goal Conduciveness

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Abstract

Several componential emotion theories suggest that appraisal outcomes trigger characteristic somatovisceral changes that facilitate information processing and prepare the organism for adaptive behavior. The current study tested predictions derived from Scherer's Component Process Model. Participants viewed unpleasant and pleasant pictures (intrinsic pleasantness appraisal) and were asked to concurrently perform either an arm extension or an arm flexion, leading to an increase or a decrease in picture size. Increasing pleasant stimuli and decreasing unpleasant stimuli were considered goal conducive; decreasing pleasant stimuli and increasing unpleasant stimuli were considered goal obstructive (goal conduciveness appraisal). Both appraisals were marked by several somatovisceral changes (facial electromyogram, heart rate [HR]). As predicted, the changes induced by the two appraisals showed similar patterns. Furthermore, HR results, compared with data of earlier studies, suggest that the adaptive consequences of both appraisals may be mediated by stimulus proximity.

Keywords: emotion, appraisal, intrinsic pleasantness, goal conduciveness, adaptive physiological response preparation, facial EMG, heart rate

Appraisal-Driven Somatovisceral Response Patterning:

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Research to date has failed to reliably reveal prototypical physiological response profiles for so-called basic emotions such as surprise, joy, and sadness (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Stemmler, 1989, 1992). Only the differences been anger and fear have consistently been replicated in different experimental settings and research groups (see Stemmler, 2004, for a review). One reason for the difficulty in obtaining evidence for emotion-specific physiological response profiles may be the existence of individual differences in the appraisal of experimental conditions. Although confronted with the same overall situation, different participants may very well engage in divergent evaluations of the manipulations (e.g., Lazarus & Alfert, 1964; Speisman, Lazarus, Mordkoff, & Davidson, 1964). These different appraisal outcomes could lead to distinct physiological responding and different feeling states.

It thus may be more fruitful to adopt a bottom-up approach by systematically manipulating different emotion-constituent appraisal dimensions and measuring the respective main and interaction effects on somatovisceral variables. This approach has been adopted in a number of studies (see Pecchinenda, 2001, for an overview), demonstrating the general utility of the appraisal approach for the prediction of somatovisceral changes. For instance, for coping potential, despite different concepts and methods used by the respective researchers, results show an impressively consistent pattern: Participants who felt capable of facing a given challenge and who were willing to stay engaged in the task were characterized by heightened resource mobilization (e.g., Eubanks, Wright, & Williams, 2002; Pecchinenda & Smith, 1996; Tomaka, Blascovich, Kelsey, & Leitten, 1993; see also Elliott, 1969; Obrist, 1976).

Scherer's (1984, 2001) Component Process Model (CPM) provides a framework for a systematic investigation of the link between different kinds of appraisal and somatovisceral responses. According to this model, the appraisal process and its efferent effects on somatovisceral responding occur in a strictly ordered sequence (for evidence, see Aue, Flykt, & Scherer, 2007). The *relevance detection* of an event (including novelty, intrinsic pleasantness, and goal relevance appraisals) should precede the *implication assessment* of the event (with causal attribution, outcome probability, discrepancy from expectation, goal/need conduciveness, and urgency appraisals). Next, an individual should appraise her or his *coping potential* (comprising control, power, and adjustment appraisals) before finally evaluating the *normative significance* of the event (including internal and external standards appraisals). Thus, the CPM covers an extensive set of appraisal criteria, in addition to coping potential, and offers concrete hypotheses as to the somatovisceral changes expected to occur as adaptive effects of specific appraisal outcomes (see Smith, 1989, for a similar approach).

In order to test the CPM predictions, Van Reekum et al. (2004) manipulated appraisals in a computer game. Different outcomes of the *goal conduciveness* appraisal resulted from either attaining the next level in the game (goal conducive) or losing a spaceship (goal obstructive). The *intrinsic pleasantness* appraisal was manipulated by the onset of pleasant or unpleasant sounds whenever a participant reached the next level or lost a spaceship. Each level of intrinsic pleasantness was combined with each level of goal conduciveness. The only significant result obtained for the intrinsic pleasantness appraisal was that the unpleasant sounds provoked higher skin conductance response amplitudes than did the pleasant sounds. In contrast, several somatovisceral variables were affected by the goal conduciveness appraisal in this study. Skin conductance response amplitudes and activity measured at the M. extensor digitorum site were more elevated in participants after they lost the spaceship (obstructive event) than after they reached the next level (conducive event). Furthermore, a higher heart rate (HR) and shorter pulse transit time were observed for obstructive trials than for conducive trials. Taken together, these responses indicate stronger resource mobilization for the obstructive as compared with the conducive events. Although suggestive, these results need replication and extension.

Importantly, this study did not measure facial muscle activity at the M. corrugator supercilii and M. zygomaticus major sites, which might have reflected the coexistent influence of both appraisals. Smith and his collaborators (e.g., Pope & Smith, 1994; Smith, 1989), using a related theoretical frame, reported activity at the zygomaticus major site to be positively related to the pleasantness of an imagined scenario. Additionally, activity at the corrugator supercilii site in their studies was an indicator of perceived goal obstacles (equivalent to Scherer’s [1984, 2001] goal conduciveness check). Finally, Aue et al. (2007) observed that activity at the zygomaticus major site varied as a positive function of goal conduciveness, thus suggesting that both stimulus pleasantness and goal conduciveness influence activity at this site.

Apart from the studies described earlier (Pope & Smith, 1994; Smith, 1989; Van Reekum et al., 2004), a systematic investigation of the respective effects of appraisals such as intrinsic pleasantness and goal conduciveness on somatovisceral responding is still lacking. This neglect may be because these two criteria are often subsumed under a single valence dimension, whereas it should be possible to distinguish between two different appraisals, intrinsic pleasantness and goal conduciveness, projecting to the valence dimension. According to the CPM (Scherer, 1988, 2001), intrinsic pleasantness refers to the inherent agreeableness of a stimulus or the general likelihood that it produces pleasant or unpleasant sensations and feelings, independent of the actual motivational state of the individual. Chocolate cake, for example, should be intrinsically pleasant for most people, even when an individual is not hungry at that moment. In contrast, goal conduciveness describes whether an event facilitates or obstructs goal attainment, and is consequently more context dependent. For example, a person on a diet, whose goal is the loss of weight, should experience being presented with an intrinsically pleasant slice of chocolate cake as goal obstructive. Whereas the effect of intrinsic pleasantness (or inherent stimulus valence) has been extensively studied (e.g., Lang, Greenwald, Bradley, & Hamm, 1993; see Bradley, 2000, for an overview), systematic investigations of the effect of goal conduciveness on somatovisceral responding, as well as of the interactions between the two appraisal criteria, are rare.

The aim of the current study was to critically test the predictions on the appraisal-physiology link in Scherer’s CPM. We focused on the intrinsic pleasantness and goal conduciveness appraisals and aimed at examining whether both would have an effect on physiological responses. Because of their theoretical affinity, CPM predictions for the goal conduciveness appraisal consist mostly of extrapolations from the hypothesized effects of intrinsic pleasantness appraisals. These extrapolations are based on the assumption that the pleasure and displeasure reactions of the genetically based or learned preference-based pleasantness check generalize to positive or negative goal conduciveness evaluations (Scherer, 1987, 2001). Such an idea received support by a recent study in our laboratory (Aue et al., 2007), suggesting that activity at the zygomaticus major site, for instance, often taken as an indicator of pleasant states (e.g., Cacioppo, Petty, Losch, & Kim, 1986; Smith, 1989), also reflects goal conduciveness. Hence, we wanted to investigate to what extent the two appraisals produce kindred patterns of physiological effects. Similar response patterns for intrinsically pleasant stimuli and goal conducive situations were expected. Comparably, similar patterns were predicted for intrinsically unpleasant stimuli and goal obstructive situations.

The current study was designed to allow a direct comparison with earlier studies that have been conducted in the tradition of dimensional valence × arousal theories (e.g., Bradley, 2000; Hamm, Schupp, & Weike, 2003). Experimental manipulations were realized in a picture-viewing paradigm, similar to the paradigms used in the dimensional tradition. Intrinsic pleasantness was operationalized by choosing pictures with different valence scores. The presentation of pleasant images can be supposed to provoke approach tendencies, whereas the presentation of unpleasant pictures can be assumed to provoke withdrawal tendencies (e.g., Lang et al., 1993). Visual cues such as increasing or decreasing concentric circles (Neumann & Strack, 2000) have been shown to successfully trigger the subjective experience of approach and withdrawal. Consequently, goal conduciveness was operationalized as a function of picture valence and an imposed picture size change (describing to what extent an individual’s action tendency was congruent with the occurring action). Instances when an unpleasant picture decreased in size or a pleasant picture increased in size were considered goal conducive. Situations in which an unpleasant image increased in size or a pleasant image decreased in size were thought to be goal obstructive.

On the basis of CPM predictions and the results of earlier work, we expected more elevated activity at the zygomaticus major site during the presentation of pleasant pictures than during the presentation of unpleasant pictures. Furthermore, we predicted goal conducive rather than goal obstructive events to provoke an increase in zygomaticus activity, mirroring the participant’s contentment with the situation (e.g., Aue et al., 2007). Activity at the corrugator supercilii site, in contrast, was expected to most strongly increase in response to unpleasant pictures and goal obstructive situations. The latter assumption is also based on the observation that circumstances that complicate reaching a goal demand increased mental effort to find an adequate solution to overcome the obstacle (Darwin, 1872/1965; Pope & Smith, 1994; Waterink & van Boxtel, 1994).

Finally, the CPM predicts that HR can serve as a marker of general metabolic resource mobilization for action preparation and should be related to required effort. Something that is unpleasant or goal obstructive should demand more effort to act upon a given situation than should something that is pleasant or goal conducive. Therefore, a larger increase in HR was expected for unpleasant as compared with pleasant images (see also Van Reekum et al., 2004). In addition, stronger HR acceleration was predicted for the obstructive than for the conducive trials.

Method

Participants

Forty-four female undergraduates of the University of Geneva, aged between 19 and 28 years (M = 22.0; SD = 2.25), participated in this study. They were recruited in an introductory psychology course and via ads posted in the university. Most of them (n = 23) were first-year psychology students, who fulfilled a course requirement. The other participants were paid 15 Swiss francs each. Exclusion criteria for participation were (a) medical treatment, (b) pregnancy, (c) drug abuse, and (d) age below 18 or above 35 years. All participants had normal or corrected-to-normal vision.

Stimuli

Ten unpleasant and 10 pleasant pictures were chosen from Lang, Bradley, and Cuthbert's (1999) International Affective Picture System (IAPS). Ten neutral images served as filler items. Unpleasant and pleasant pictures were matched for subjective arousal. The respective pleasantness and arousal ratings, on a scale from 1 (*very unpleasant/not at all arousing*) to 9 (*very pleasant/extremely arousing*), were as follows: unpleasant (2.3/5.7) and pleasant (7.8/5.1). [1]

Following participants' arm movements in response to symbols appearing on top of the presented images, the images either increased or decreased in size, thus visually giving the impression of approach or withdrawal. The increase of unpleasant images and the decrease of pleasant images were considered goal obstructive. Conversely, the decrease of unpleasant images and the increase of pleasant images were considered goal conducive.

Experimental Design

The experimental design was a 2 × 2 within-subjects design resulting from the manipulation of the factors *Intrinsic Pleasantness* (two levels: unpleasant, pleasant) and *Goal Conduciveness* (two levels: obstructive, conducive).

Setting and Apparatus

Participants sat comfortably in a reclining position, facing a computer screen (Sony CPD-E400E) at a distance of approximately 1.4 m (picture size: 16 cm × 24 cm) in a sound attenuated room (3.50 m × 4 m). A QuickShot Warrior 5 QS-123 joystick (El Monte, CA, USA) was placed either on the right or the left side of the participant, permitting the execution of arm extension (push) and arm flexion (pull). The maximum displacement in either the extension or the flexion direction implied a movement of the participants' hand by 10 cm. The participants' arms were placed on an armrest to prevent fatigue to the largest possible extent. Physiological data was acquired continuously with the Biopac TEL 100 Remote Monitoring System (Santa Barbara, CA, USA). The sampling rate was set to 1000 Hz. Different settings were used for the electrocardiogram and electromyogram (EMG) channels (see Dependent Variables for details).[2] Signals were transferred from the experimental room to the MP100 Acquisition Unit (16 bit A/D conversion) in the control room and stored on computer hard disc (HP Compac d530 CMT). Three separate digital channels received inputs from the presentation computer and recorded on-and offset of (a) a picture (1^{st} second of picture presentation), (b) the superposition of the push/pull symbol onto the picture (2^{nd} second of picture presentation), and (c) the display of the picture in its new size (3^{rd} to 7^{th} second of picture presentation). Experimental control, such as picture presentation and computer synchronization, was performed by the Experimental Run Time System (ERTS, version 3.28; BeriSoft Cooperation, Frankfurt am Main, Germany), running on the presentation computer. A hidden camera (Sony EVI-D31) permitted the detection of larger body movements impinging on physiological responses.

Procedure

Participants were told that they were taking part in an experiment on sensorimotor coordination involving the registration of bodily reactions. After arriving in the laboratory, participants signed an informed consent form and electrodes were placed on them. Next, a 5-min relaxation period began, which allowed the participants to become familiar with the experimental setting and to establish and register a physiological baseline. The performance task consisted of looking at 30 pictures presented on a computer screen and reacting as rapidly as possible to two symbols appearing superimposed on the pictures (400 × 300 pixels) 1 s after picture onset. These symbols instructed the participants to either push (pyramid form directed upward) or to pull (pyramid form directed downward) the joystick. Following the participants' arm movements, the image either increased (640 × 480 pixels) or decreased (156 × 117 pixels) in size. The picture in its new size was then presented for 5 s. Finally, a black screen was shown for about 2.5 s (random time interval between 2 and 3 s). The push symbol and the pull symbol were projected onto 15 images each. Within every level of Intrinsic Pleasantness, participants were asked to push the joystick five times and to pull it another five times. There was no fixed combination of picture and push/pull symbol in order to avoid effects resulting from specific combinations of picture content and push/pull symbol.

For half of the participants (Group Ext-), the image size became smaller when they pushed the joystick and larger when they pulled the joystick; for the other half (Group Ext+), it was the reverse. By having these two groups, we prevented the visual effects (increasing versus decreasing picture size) from being confounded with a specific arm movement. For similar reasons, half of the participants performed the task with their right arm, whereas the others used their left arm (not confounded with the group manipulation).

Participants were informed that the four best performers would win 50 CHF each. Criteria for good performance were (a) no movement errors (e.g., pulling the joystick when pushing was requested or vice versa) and (b) short reaction times. Participants then went through a training period of 10 trials before starting with the block of 30 pictures, which was the basis for their performance estimate. This block was preceded by one irrelevant neutral picture to ensure that reactions to the first relevant picture were not simply an effect of surprise.

After the performance block, the participants reviewed and evaluated each picture on a continuous scale and were asked to what extent the image was perceived as being unpleasant or pleasant. In a postinterview, participants were asked about their hypotheses concerning the aim of the study, their involvement, and their physical and psychological well-being. None of the participants reported having been disturbed (either physically or psychologically) and none guessed the real aim of the study. All participants indicated having been sufficiently involved in the task (M = 2.1, SD = 1.02) on a scale ranging from 0 (*not at all*) to 4 (*extremely*). Before leaving the laboratory, participants were debriefed.

Dependent Variables

EMG activity at the muscle sites M. zygomaticus major and M. corrugator supercilii. Skin was first cleansed with PDI (Orangeburg, Canada) electrode prep pads consisting of 70% alcohol and pumice to reduce skin impedance below 5 kΩ. Facial muscle activity was recorded according to the guidelines of Fridlund and Cacioppo (1986) with two 4-mm Biopac Ag/AgCl surface electrodes per site, filled with Signa Gel (Parker Laboratories, Fairfield, NJ, USA). Electrodes were fixed on the participants' left body side. A ground electrode was placed at the midline of the forehead. Amplification was set to 2,000 and signals were high-pass filtered (30 Hz). Signals were then rectified and smoothed by a moving average (length: ± 25 ms).

Heart rate. Electrocardiogram was measured by the use of Biopac pre-gelled disposable Ag/AgCl electrodes (10-mm sensor diameter). Electrodes were fixed according to Einthoven II, one below the right clavicle and another below the left lateral margin of the chest. Amplification was 500, and filters were set to 1 and 45 Hz.

Data Analysis

Preprocessing of the data. Parameterization was performed with the program PPP 7.12 (2005; eXtra Quality Measurement Systems, Frankfurt am Main, Germany). PPP allowed the assessment of heart period (in seconds), which was then transformed into HR (in beats per minute). Mean EMG activity and HR during the 2 s before picture onset served as baseline and were subtracted from mean EMG activity and HR during each of the five 1-s intervals following picture size change (3^{rd} to 7^{th} second of picture presentation).

Outliers (deviating more than 3 SD from a participant's mean in any physiological variable) were identified with JMP statistical software (SAS Institute Inc., 1995) and set to missing data (~ 3% of the data). EMG measures were transformed by the natural logarithm because of positive skewness.

One participant was excluded from all statistical analyses because she displayed too many errors in the reaction time task (more than 10% of all trials; a detailed description of the reaction times is reported elsewhere; Aue, 2006). For all remaining participants, physiological responses related to errors (on average, 1% of all trials) or reaction time outliers (1%) in the performance block were expelled. Furthermore, because of electrode detachment during the experiment, another participant was excluded from statistical analyses concerning activity at the zygomaticus major site. Finally, because of movement artifacts, a third participant was excluded from HR analyses.

Statistical analyses. A three-factorial analysis of variance (ANOVA) for repeated measures with the factors intrinsic pleasantness (two levels: unpleasant, pleasant), goal conduciveness (two levels: obstructive, conducive), and time (five levels: 2-3 s, 3-4 s, 4-5 s, 5-6 s, and 6-7 s after picture onset) was calculated. In the case of nonsphericity, effects were Greenhouse-Geisser corrected. All reported effect sizes are partial η^2 and are simply noted as η^2. Main effects for time, irrelevant for the aim of our research, will not be reported.

Results

Results for facial EMG are in accordance with predictions. Pleasant images were characterized by higher activity at the zygomaticus major site than were unpleasant images, $F(1, 41) = 8.47$, $p < .01$ (*M*s = .15 and .05, respectively; see Figure 1). Comparably, goal conducive events (decrease of unpleasant and increase of pleasant images) provoked greater activity at the zygomaticus major site than did goal obstructive events (increase of unpleasant and decrease of pleasant images), $F(1, 41) = 5.73$, $p < .05$, $\eta^2 = .12$ (*M*s = .13 and .07, respectively).

Insert Figure 1 about here

Furthermore, unpleasant images were associated with higher activity at the corrugator supercilii site than were pleasant images, $F(1, 42) = 18.68$, $p < .001$, $\eta^2 = .31$ (Ms = .04 and -.07, respectively; Figure 2). Also as predicted, greater activity at the corrugator supercilii site was provoked by goal obstructive as compared with goal conducive events, $F(1, 42) = 4.03$, $p = .05$, $\eta^2 = .09$ (Ms = .00 and -.03, respectively). This effect for goal conduciveness was not constant over time as indicated by the significant interaction time × goal conduciveness, $F(4, 168) = 4.08$, $p < .01$, $\eta^2 = .09$. No difference between obstructive and conducive trials was observed immediately following picture size change, $F(1, 42) = 0.26$, *ns*, $\eta^2 = .01$ (2 to 3 s after picture onset). Goal obstructive as compared with goal conducive events were associated with higher activity for the remaining time intervals following picture size change, range of Fs(1, 42) = 4.27 - 5.06, all ps < .05, range of η^2s = 09 - .11. In addition, the ANOVA revealed a significant valence × goal conduciveness interaction, $F(1, 42) = 6.79$, $p < .05$, $\eta^2 = .12$. An effect of goal conduciveness for activity at the corrugator supercilii site was found for pleasant images only, Fs(1, 42) = 0.44 and 13.78, *ns* and = .001, η^2 = .01 and .25, for unpleasant and pleasant, respectively.

Insert Figure 2 about here

Contrary to expectations, pleasant images were associated with overall larger HR change scores than were unpleasant pictures, $F(1, 41) = 4.73$, $p < .05$, $\eta^2 = .10$ (Ms =1.33 and 0.52, respectively; Figure 3). The significant valence × time interaction revealed that pleasant and unpleasant images differed from 3 to 6 s following picture onset (1 to 4 s following picture size change), range of *F*s(1, 41) = 3.38 - 7.47, range of *p*s = .07 - < .01, range of η^2s = .07 - .15, whereas no difference existed immediately after picture size change (2 to 3 s after picture onset), $F(1, 41) = 0.15$, *ns*, $\eta^2 = .00$, and at the very end of the picture presentation (6 to 7 s after picture onset), $F(1, 41) = 1.18$, *ns*, $\eta^2 = .03$. Further, contrary to CPM predictions, goal conducive events were associated with overall larger HR change scores than were goal obstructive events, $F(1, 41) = 5.13$, $p < .05$, $\eta^2 = .11$ (*M*s = 1.34 and 0.51, respectively). Again, the two main effects for intrinsic pleasantness and goal conduciveness were qualified by the significant valence × goal conduciveness interaction, $F(1, 41) = 11.11$, $p < .005$, $\eta^2 = .21$. This effect arose because of the pronounced deceleration for increasing (obstructive) unpleasant images. Whereas no difference was observed between obstructive and conducive events for the pleasant images, $F(1, 41) = 1.57$, *ns*, $\eta^2 = .04$, larger HR change scores were observed for conducive than for obstructive events during the presentation of unpleasant images, $F(1, 41) = 14.06$, $p < .001$, $\eta^2 = .26$. Finally, all described effects were further qualified by the significant valence × goal conduciveness × time interaction, $F(4, 164) = 4.54$, $p < .01$, $\eta^2 = .10$. Differences between the unpleasant-obstructive trials and the remaining trials were particularly strong from 2 to 5 s following picture size change (4 to 7 s following picture onset), range of *F*s(1, 41) = 3.76 - 18.28, range of *p*s = .06 - < .001, range of η^2s = .08 - .30.[3]

Insert Figure 3 about here

Discussion

Evidence for Similar Response Patterns for Intrinsic Pleasantness and Goal Conduciveness Appraisals

We were able to demonstrate that both the intrinsic pleasantness and the goal conduciveness appraisal affect somatovisceral responding. Hypotheses were fully supported for facial EMG and our data are consistent with earlier observations (e.g., Aue et al., 2007; Pope & Smith, 1994; Smith, 1989). Importantly, the current results for facial EMG during the viewing of IAPS slides largely replicate findings reported by researchers outside the appraisal tradition (e.g., Bradley, 2000; Bradley, Codispoti, Cuthbert, & Lang, 2001).

In contrast, results for HR did not support CPM predictions. Unpleasant images were associated with a *lower*—not larger—HR change scores than were pleasant images. This finding mirrors to a large extent the findings reported by authors working on dimensional models of emotion (e.g., Hamm et al., 2003; Lang, Bradley, & Cuthbert, 1990). Likewise, CPM hypotheses for the influence of goal conduciveness on HR, although supported by earlier work (Van Reekum et al., 2004), were not confirmed here. Our results thus point to the need to revise CPM hypotheses, at least with respect to experimental paradigms such as the one used in the current study. Importantly, Lang and collaborators (Hamm, Gerlach, Globisch, & Vaitl, 1992; Vrana & Lang, 1990) point to the context dependency of HR responses. More specifically, in Lang's (e.g., Bradley & Lang, 2000) defense cascade model, a predator at distance (e.g., shown in a picture) is thought to evoke bradycardia, supposedly reflecting vigilance. In contrast, at proximity, the predator should elicit tachycardia, signaling metabolic requirements for an adaptive fight-or-flight response preparation (defense response). In contrast to earlier research that included real-life situations (e.g., Van Reekum et al., 2004), instead of displaying a defense response, our participants may have demonstrated more vigilance or orientation toward the unpleasant and the obstructive events (and especially for the unpleasant obstructive events). The fact that there were no “proximate” stimuli in the present experiment thus could explain the lack of supporting evidence for CPM hypotheses. Future research may need to differentiate more clearly between predictions for real-life versus symbolic situations.

Our results for HR further point toward the possibility of the participants’ disengagement in the trials comprising unpleasant images and obstructive situations (e.g., Eubanks et al., 2002; Obrist, 1976; Pecchinenda & Kappas, 1995; Tomaka et al., 1993). Again, with proximate threat stimuli, which cannot easily stay unattended, and which usually call for urgency of response preparation, this finding might have been different. Finally, it is also important to note that Fowles, Fisher, and Tranel (1982) reported HR to increase with reward. Thus, an alternative explanation of the results of the current study is that the pleasant pictures and the conducive events have been experienced as more rewarding than the unpleasant pictures and the obstructive events.

Most important, similar EMG and HR responses were observed for intrinsic pleasantness and goal conduciveness, emphasizing once more the close affinity of both appraisals. However, from our data, it is not clear whether these two appraisals combine in an additive, multiplicative, or other manner. Maybe this affinity even differs with respect to the variable considered. Whereas our zygomaticus data suggest additive effects, corrugator and HR data suggest that a goal conducive event could produce slightly different effects when it concerns a pleasant stimulus than when it concerns an unpleasant one (i.e., nonadditive effects of intrinsic pleasantness and goal conduciveness). The latter is in accordance with evidence for an interaction of power and control appraisals with respect to their effect on electrodermal responding (Van Reekum, Johnstone, & Scherer, 1997). Specifically, results of the current study revealed that goal conduciveness effects at the corrugator supercilii site were stronger for pleasant than for unpleasant images, whereas the reverse was the case for HR. However, given some limitations of the current study, as outlined in the following section, firm conclusions concerning the nature of the interplay between the peripheral effects of intrinsic pleasantness and goal conduciveness appraisals cannot be drawn.

Limitations of the Current Study

It is important to note that our manipulation of the goal conduciveness appraisal can be considered as somewhat artificial because there was never a goal obstructive (goal conducive) situation in which a pleasant stimulus increased (decreased) in size or an unpleasant stimulus decreased (increased) in size. This may have influenced the pattern of our data to a certain extent. For instance, decreasing picture size was associated with a higher HR than was increasing picture size for unpleasant images and, towards the end of our analyzed time interval, tendentiously also for pleasant images (Figure 3). However, the fact that the difference in HR between increasing picture size and decreasing picture size was much larger for the unpleasant than for the pleasant images suggests that the pattern of results cannot be attributed to size change alone, but that additional factors must have been at play. Hence, in our study, the effect of picture size increase (associated with HR decrease) may have counteracted the effect of goal conduciveness (HR increase) for the pleasant images. On the contrary, the effect of picture size decrease (HR increase) may have supported the effect of goal conduciveness (HR increase) for the unpleasant images. The same explanation could hold for activity at the corrugator supercilii site. For unpleasant images, an effect of picture size decrease (activity increase) may have counteracted the effect of goal conduciveness (activity decrease), whereas, for pleasant images, an effect of picture size increase (activity decrease) may have supported it. This could elucidate why there was no goal conduciveness effect for unpleasant images.

Whether increased size of pleasant and decreased size of unpleasant images really have a comparable status for goal conduciveness remains to be clarified as well. In a similar vein, it is questionable whether the increase of unpleasant and the decrease of pleasant images are comparably goal obstructive. One can associate clearly different emotions with the increase of pleasant images (e.g., joy, happiness) and the decrease of unpleasant images (e.g., relief). The same applies to the size increase of unpleasant images (e.g., fear, disgust) and the decrease of pleasant images (e.g., disappointment). This could also explain the nonadditive effects of intrinsic pleasantness and goal conduciveness for corrugator and HR data.

Finally, it is possible that some of our participants even enjoyed looking at the increasing unpleasant images (e.g., sensation seeking; Zuckerman, 1991), producing noise in our data. Consequently, subsequent studies should include participants who are homogeneous in their action tendencies toward the affectively laden pictures. Investigators can then more confidently predict whether an increase or a decrease will be experienced as goal conducive or goal obstructive.

Summary and Conclusions

The present study confirms that several somatovisceral variables are potentially reliable markers of the emotion-constituent appraisal process. We observed similar response patterns for intrinsic pleasantness and goal conduciveness, which emphasizes their theoretical proximity. Future research should include a larger number of somatovisceral variables to permit a systematic investigation of similarities and potential differences of the appraisals' respective efferent effects. Data from a follow-up study (Aue & Scherer, 2008) suggest that both appraisals produce kindred, but not identical, somatovisceral response patterns when additional measures such as forehead temperature are included.

Another issue concerns the interaction between the two appraisal checks studied here. As has been outlined earlier, it is not yet clear whether intrinsic pleasantness and goal conduciveness outcomes combine in an additive, multiplicative, or other manner. Unfortunately, from the present study, safe conclusions cannot be drawn because goal conduciveness was always defined as a function of intrinsic pleasantness combined with picture size change. Thus, differential goal conducivness effects for unpleasant and pleasant images could also be linked to differences in picture size. Subsequent studies should therefore develop experimental designs that can more stringently test the type of interaction of the two appraisals (e.g., containing trials in which a person on a diet is confronted with ever-increasing sizes of chocolate bars).

One of the major insights provided by the current results is the need to examine whether the conditions required for the validity of certain hypotheses are met. Future research should distinguish between real situations and symbolic or spectator situations.

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Footnotes

[1]All pictures were rated for their intrinsic pleasantness by the participants of the current study. The subjective arousal ratings for the images, however, are based on several studies with female participants by Lang et al. (1999); these ratings are distributed along with the pictures on a CD. To eliminate strong differences in complexity between the levels of the Intrinsic Pleasantness factor, we ran a pretest study for an initial picture set with 15 female second-year psychology students. On the basis of this pretest, we replaced the pictures that were found to be extreme (either high or low) for complexity with others from the CD.

[2]Electrodermal activity was also recorded. Because all statistical analyses for electrodermal activity failed to achieve significance, data will not be reported here.

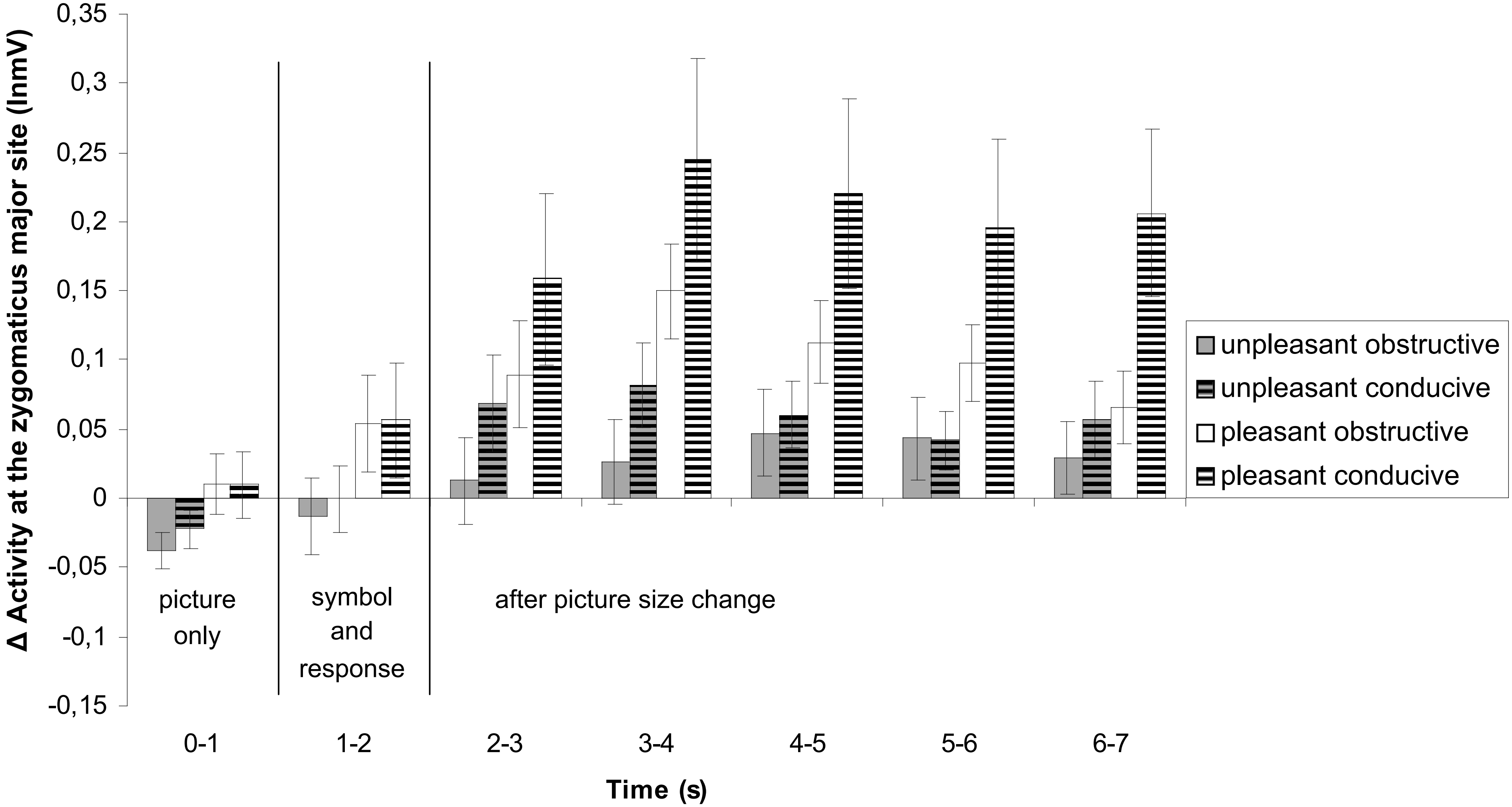
[3]Activity at the zygomaticus major site was also greater for pleasant as compared with unpleasant images before picture size change (0 to 2s after picture onset), whereas the reverse was true for activity at the corrugator supercilii site. No difference in HR between pleasant and unpleasant images was observed during that time.

Figure Captions

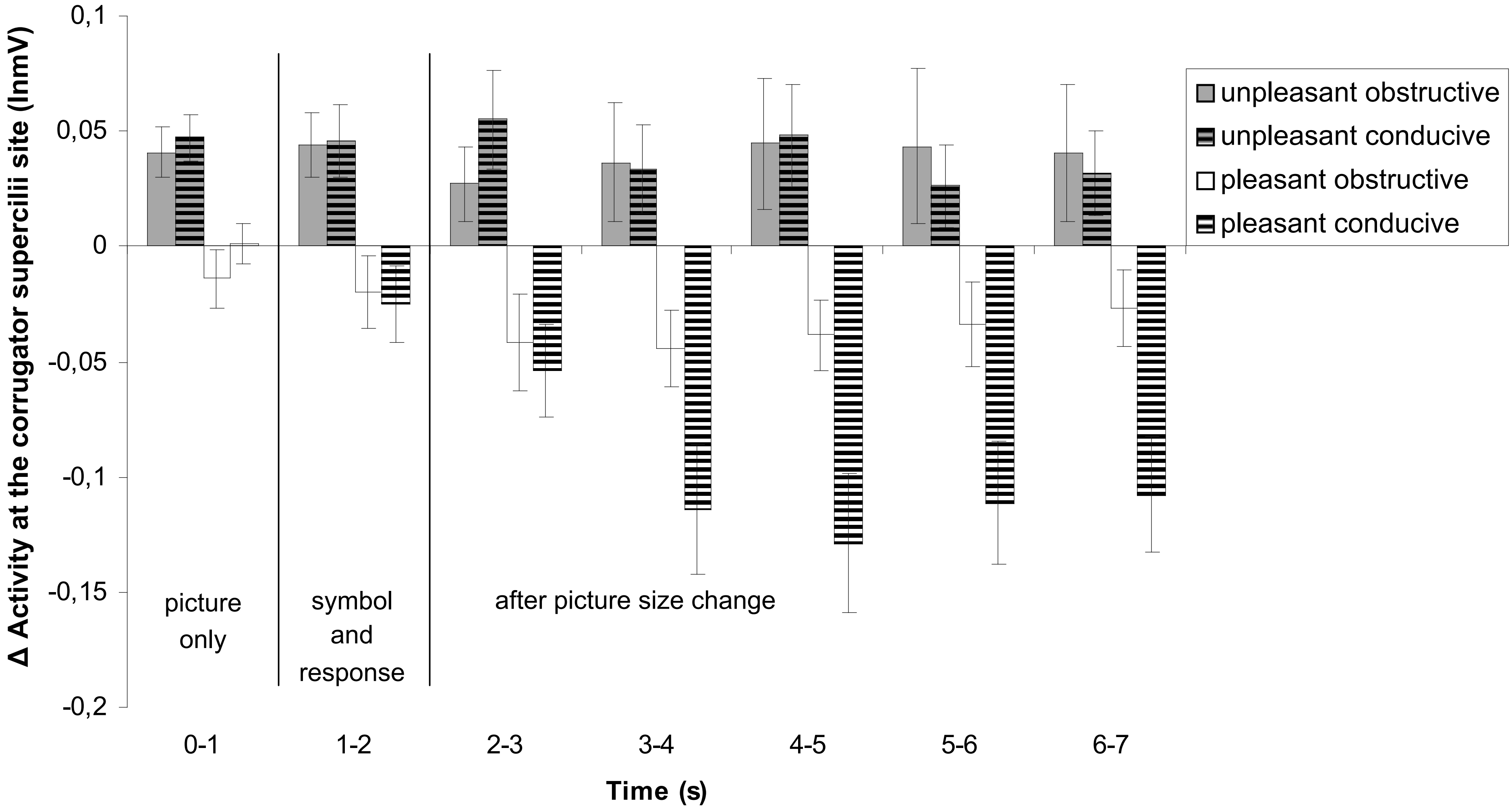
Figure 1. Change in activity at the zygomaticus major site as a function of intrinsic pleasantness, goal conduciveness, and time. Values are based on differences between logarithmic scores (logarithmic task scores – logarithmic baseline scores). Error bars depict standard errors.

Figure 2. Change in activity at the corrugator supercilii site as a function of intrinsic pleasantness, goal conduciveness, and time. Values are based on differences between logarithmic scores (logarithmic task scores – logarithmic baseline scores). Error bars depict standard errors.

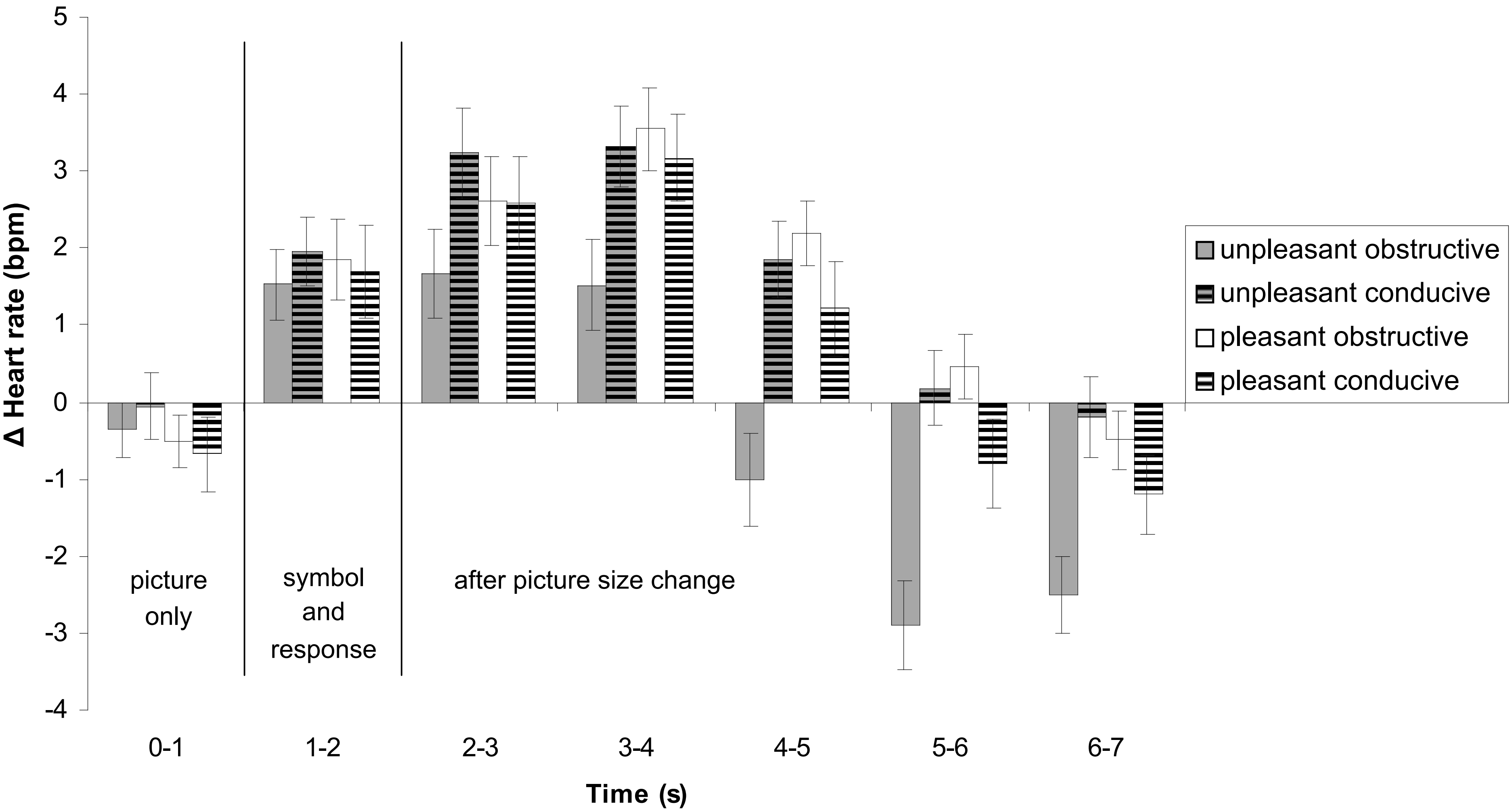
Figure 3. Change in heart rate as a function of intrinsic pleasantness, goal conduciveness, and time. Error bars depict standard errors.



Δ Activity at the zygomaticus major site (lnmV)
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
-0,05
-0,1
-0,15
picture only
symbol and response
after picture size change
unpleasant obstructive
unpleasant conducive
pleasant obstructive
pleasant conducive
0-1
1-2
2-3
3-4
4-5
5-6
6-7
Time (s)



Δ Activity at the corrugator supercilii site (lnmV)
0,1
0,05
0
-0,05
-0,1
-0,15
-0,2
unpleasant obstructive
unpleasant conducive
pleasant obstructive
pleasant conducive
picture only
symbol and response
after picture size change
0-1
1-2
2-3
3-4
4-5
5-6
6-7
Time (s)


5
4
3
2
1
0
-1
-2
-3
-4
Δ Heart rate (bpm)
picture only
symbol and response
after picture size change
0-1
1-2
2-3
3-4
4-5
5-6
6-7
Time (s)
unpleasant obstructive
unpleasant conducive
pleasant obstructive
pleasant conducive